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Fibre-reinforced plastic composites — Determination of open-hole compression strength

Composites plastiques renforcés de fibres — Détermination de la résistance à la compression avec trou nu

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12817 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

Introduction

In preparing this (harmonized) International Standard, reference has been made to other similar open-hole compression methods (JIS K 7093,[1] ASTM D6484/D6484M-09[2]) and related methods, i.e. open-hole tension in ASTM D5766/D5766M6[3] and pin-bearing in ISO 12815.[4]

The scope covers all current and future fibre-reinforced plastic composites meeting the requirements of this International Standard. This International Standard incorporates three methods that have different suitability and do not necessarily yield identical properties. All the methods use the maximum load to define the open-hole compressive strength.

Fibre-reinforced plastic composites — Determination of open-hole compression strength

1 Scope

This International Standard specifies the test method to determine the open-hole compressive strength of laminated fibre-reinforced plastic composites. The laminate is intended to be a balanced and symmetrical lay-up or be otherwise homogeneous through the thickness. This International Standard applies to all textile diameter fibre types (carbon, glass, aramids, etc.) and matrices (e.g. thermoset, thermoplastic) that meet the requirements of this International Standard.

This International Standard includes three methods:

— method 1 (short specimen with support fixture);

— method 2 (short specimen without support fixture);

— method 3 (long specimen with support fixture as in ASTM D6484/D6484M-09, methods A and B).

Method 1 employs an L-shaped base fixture and two end fixtures. These end fixtures are compressed between the platens of the test machine.

Method 2 employs end supports similar to the fixtures given in C.1 of ISO 14126:1999. Method 2 is useful for cyclic loading conditions test, including under fully or partly reversed loading conditions when the specimen is clamped by hydraulic grips without support fixtures

Method 3 has two types of loading methods, i.e. 3A and 3B. In method 3A, the specimen is placed within a stabilization fixture, which is then clamped by hydraulic grips. In method 3B, the specimen is placed within a stabilization fixture and then end-loaded by platens. Full details of test methods 3A and 3B are given in ASTM D6484/D6484M-09, procedure A and procedure B, respectively.

NOTE Specimen configurations and force introduction varies for the three methods covered within this International Standard. Results obtained using methods 1, 2 and 3 might not be equivalent for all laminates in all environments.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472, *Plastics — Vocabulary*

ISO 1268 (all parts), *Fibre-reinforced plastics — Methods of producing test plates*

ISO 2818, *Plastics — Preparation of test specimens by machining*

ISO 5893, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Specification*

ISO 14126:1999, *Fibre-reinforced plastic composites — Determination of compressive properties in the in-plane direction*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

3.1
open-hole diameter
diameter of the open hole in the centre of the test specimen

Note 1 to entry: Open-hole diameter is expressed in millimetres (mm).

Note 2 to entry: See Figure 1.

3.2
width
w
overall width of the specimen

Note 1 to entry: Width is expressed in millimetres (mm).

3.3
coordinate axes of a test specimen
direction parallel with the plate longitudinal axis, which is the X direction and the direction perpendicular, which is the Y direction

Note 1 to entry: See ISO 1268-4.

3.4
open-hole compressive stress
value obtained by dividing a compressive load applied to a test specimen by the gross cross-section based on the overall width and thickness of the test specimen

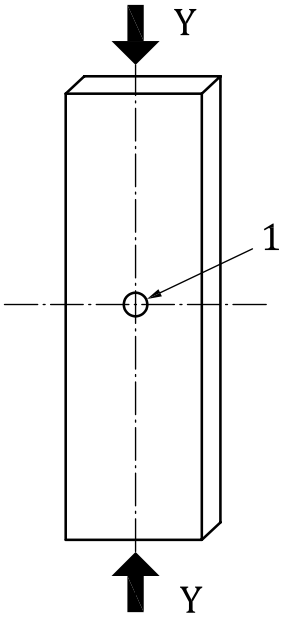
Note 1 to entry: Open-hole compressive stress is expressed in megapascals (MPa).

3.5
open-hole compressive strength
maximum open-hole compressive stress generated in the test specimen

Note 1 to entry: Open-hole compressive strength is expressed in megapascals (MPa).

4 Principle

A test specimen consisting of a strip of rectangular cross-section with a plain open hole centrally positioned, as shown in Figure 1, is loaded in compression. The maximum load sustained by the specimen is used to determine the open-hole (notched) compressive strength based on the gross specimen cross-section.



Key

Y load direction

1 open hole

Figure 1 — Open-hole laminated composite test specimen and load direction

5 Apparatus

5.1 Test machine

5.1.1 General, the machine shall conform to ISO 5893, as appropriate to the requirements given in 5.1.2 and 5.1.3.

5.1.2 Speed of testing. The test machine shall be capable of maintaining the required speed of testing (see 8.4).

5.1.3 Indication of load, the error for the indicated load not exceeding 1 %.

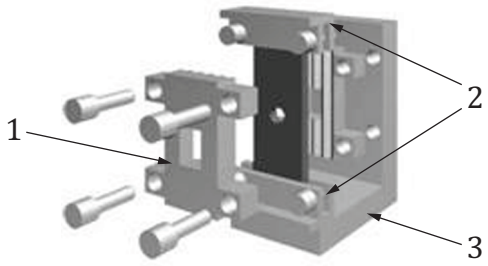
5.1.4 Load measurement system, comprising a mechanism to indicate continuously the compressive load applied to the test piece. The loading mechanism shall not cause delay due to inertia at the specified test speed and shall indicate the load value with a precision equal to or higher than ±1 % of the full scale of load cell measurement capacity.

5.1.5 Loading platens (method 1 and method 3B), each (platen plate) being located on the movable part (platen plate) and fixed part (base plate), respectively, of the test machine and the centre of the upper and lower pressing faces coinciding with the centreline of the loading direction of the test machine. The alignment of the test fixture shall enable a compressive load to be applied to the platen plate and the base plate in the axial direction of a test specimen, and forces other than the compressive load shall be minimized.

5.1.6 Hydraulic grips (method 2 and method 3A), each located on the movable and fixed parts, respectively, of the test machine and the centre of the upper and lower grips coinciding with the centreline of the load gauge. The test set-up arrangement shall be such that a compressive load is applied to the upper and lower grips in the axial direction of a test specimen, and forces other than the compressive load shall be minimized.

5.2 Test fixtures, for method 1 and method 3, which support the test specimen to prevent buckling phenomenon, and which apply compressive load to the test specimen. They shall be made of low-carbon steel or stainless steel. Figure 2 shows an outline of the out-of-plane deformation support fixture assembly for method 1. Figures 3 to 7 show detailed dimensions of the out-of-plane deformation support fixture, L-shaped base plate, end-loading fixtures and support fixture for method 1.

Method 3 requires out-of plane support fixtures. There are two compression-loading conditions for method 3, shear loaded by clamped hydraulic wedge grips (method 3A) and end loaded by platen plates (method 3B). Methods 3A and 3B require the same stabilization fixture. Details of the support fixture for method 3 are given in ASTM D6484/D6484M-09.

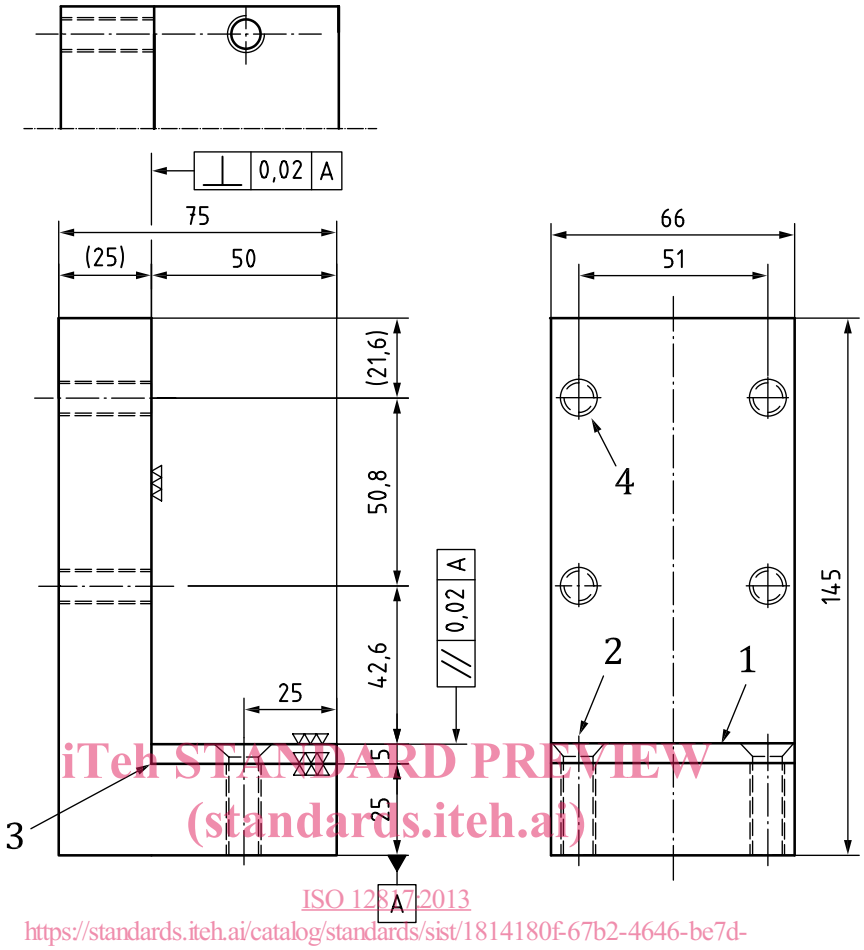


Key

1 out-of-plane deformation support fixture
2 end-loading fixtures
3 L-shaped base plate

Figure 2 — Outline of the fixture

Dimensions in millimetres



Key

1 S55C, quenched, HRC 50
2 2 × M6 countersunk screw
3 relief radius R0,1 plate R0,5
4 4 × M8 × 1,25 through

Figure 3 — L-shaped base plate for method 1